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Northern Lakes Fish Monitoring Program:

Limestone and Hanson Lakes - 1989

Technical Report 91-2



NORTHERN LAKES FISH MONITORING PROGRAM

Limestone and Hanson Lakes - 1989

by

B. L. GLOUTNEY

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Saskatchewan Fisheries Laboratory

Fisheries Branch

Department of Parks and Renewable Resources

112 Research Drive

Saskatoon, Saskatchewan, Canada

S7K 2H6

EXECUTIVE SUMMARY

Limestone and Hanson lakes were testnetted in the summer of 1989 in an attempt to evaluate the current status of their respective fisheries.

Five species of large fish comprise the Limestone Lake fishery, with walleye comprising the largest single portion (45%) of the catch by weight. These fish are abundant (309 per net set) but the population is comprised of relatively small fish representing numerous age classes.

The northern pike population rates well in terms of abundance when compared to other lakes throughout the province, and there has been a definite increase in the number of older and larger fish within the population since 1965. This may be due, in part, to the separate species limits imposed on Limestone's commercial fishery in 1986, as well as an increase in the abundance of cisco, which is a preferred prey species of pike.

Cisco is the primary target species of the commercial fishery in Limestone Lake. These fish have flourished under reduced commercial effort resulting from the poor market quality of the fish due to high infestations of black spot *Bolbophorus confusus* in their flesh.

Records show that an average of 12 125 kg ($3.5 \text{ kg} \cdot \text{ha}^{-1}$) of fish are harvested annually from Limestone Lake. This is comprised of 4127 kg ($1.17 \text{ kg} \cdot \text{ha}^{-1}$) of walleye, 1703 ($0.48 \text{ kg} \cdot \text{ha}^{-1}$) of pike, 5523 kg

(1.57 kg·ha⁻¹) of cisco, and 772 kg (0.22 kg·ha⁻¹) of other species, including whitefish. Sixty-nine percent of the total annual harvest is taken by the commercial fishery, of which 33% is walleye. The recreational fishery harvests 18%, and 13% is taken by the native and domestic fishery.

Maximum sustained yield for Limestone Lake was estimated at 6.39 kg·ha⁻¹ or 22 500 kg. The breakdown of this is as follows: 10 000 kg (2.84 kg·ha⁻¹) of walleye, and 3400 kg (0.97 kg·ha⁻¹) of pike, with 9400 kg (2.58 kg·ha⁻¹) being allocated for the harvest of cisco.

The Hanson Lake fishery is comprised of 6 large fish species, with whitefish and cisco collectively making up over 50% of the catch by weight.

The walleye population in this lake has remained virtually unchanged in terms of abundance, since 1966. Growth is rapid, but sizes tend to be relatively small, with few large fish present in the population. This suggests that upon reaching a size desired by anglers, walleye in Hanson Lake are quickly harvested.

The pike population displays characteristics similar to the resident walleye population. Although, abundance has increased since the earlier study, growth is rapid, maturation is achieved at an early age and larger members of the population are conspicuous by their absence. This leads to the conclusion that pike in Hanson Lake are subject to heavy exploitation.

Records show that average annual harvest from Hanson Lake is 10 500 kg ($2.51 \text{ kg}\cdot\text{ha}^{-1}$). Walleye and pike make up 3100 kg and 4800 kg, respectively, and whitefish comprises 2600 kg. The Native and domestic fisheries produce less than 1% of this total and the commercial fishery, which is comprised of 80% whitefish, yields a little less than a third. The recreational fishery on Hanson Lake harvests walleye and pike only and makes up approximately 70% of the total harvest from the lake.

Maximum sustained yield for Hanson Lake was estimated at 13 600 kg ($3.24 \text{ kg}\cdot\text{ha}^{-1}$), partitioned in the following manner: 1600 kg ($0.38 \text{ kg}\cdot\text{ha}^{-1}$) of walleye, 2100 kg ($0.50 \text{ kg}\cdot\text{ha}^{-1}$) of pike, and 9900 kg ($2.36 \text{ kg}\cdot\text{ha}^{-1}$) of whitefish.

The following recommendations are based on the findings of this report:

1. Following provincial guidelines, there is room for expansion in both the recreational and commercial fishery in Limestone Lake.
2. Discourage future expansion of gamefish fishery on Hanson Lake.
3. Retain spring closure of the Bad Carrot River and Bertram Bay.
4. Terminate spawn taking from the Bad Carrot River for an indefinite period of time or increase the return rate of fry to the creek.
5. Retain current commercial limits and encourage the commercial fishery for whitefish on Hanson Lake.

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1. INTRODUCTION

The fish resources of Limestone and Hanson lakes were examined during the summer of 1989. Work was conducted by personnel from the Saskatchewan Fisheries Laboratory, Fisheries Branch, Saskatchewan Parks and Renewable Resources. The most recent detailed investigations into the fish resources in these lakes were previously conducted in 1965 and 1966, respectively.

There are no motels, outfitters, campgrounds, or other forms of accommodations available at Limestone Lake, but two outfitters on Deschambault Lake have licensed day-use of the lake's fish resources. In addition, there is an old boat launch located at the north end of the lake, providing access for fishing enthusiasts. Hanson Lake has one outfitting lodge, including a campground, at Bertram Bay, and a second, provincially managed, rustic campground on the former mine site of Western Nuclear Mines. Both provide boat launch facilities.

The primary goal of the current study was to determine the current status of the resource within each lake and use the resulting information as a basis for future management decisions. When possible, results from the current studies were compared to results from the earlier studies.

2. DESCRIPTION OF THE STUDY AREA

Limestone Lake ($54^{\circ}38' 103^{\circ}13'$) and Hanson Lake ($54^{\circ}42' 102^{\circ} 51'$) are located in east central Saskatchewan, and form part of the Saskatchewan River drainage basin (Fig. 1). Limestone Lake lies on the Deschambault Lake Plain, where Paleozoic beds overlap and join the rock of the Precambrian Shield. This region is characterized by poor soil development and limestone outcroppings (Lane, 1967). Hanson Lake lies on the Precambrian Shield, surrounded by muskeg and underlain by igneous and sedimentary rock formations (Richards and Fung, 1969).

Limestone Lake is small and shallow. It covers an area of 3517 ha (Table 1), has a maximum depth of 7.0 m, and a mean depth of only 3.2 m (Lane, 1967). Hanson Lake is larger, having a water surface area of approximately 4190 ha (Table 2). The deepest point extends to 32.8 m but overall mean depth is 7.9 m (Sawchyn, 1967).

Prior to 1963, travel to these lakes, as well as a multitude of other large and small lakes in northern Saskatchewan, was restricted by lack of road access. In 1963, the Hanson Lake Road (Highway 106), which runs from Smeaton to Flin Flon, Manitoba, was completed and exposed lakes in the area to a higher level of utilization by campers, boaters, swimmers, and fishermen.

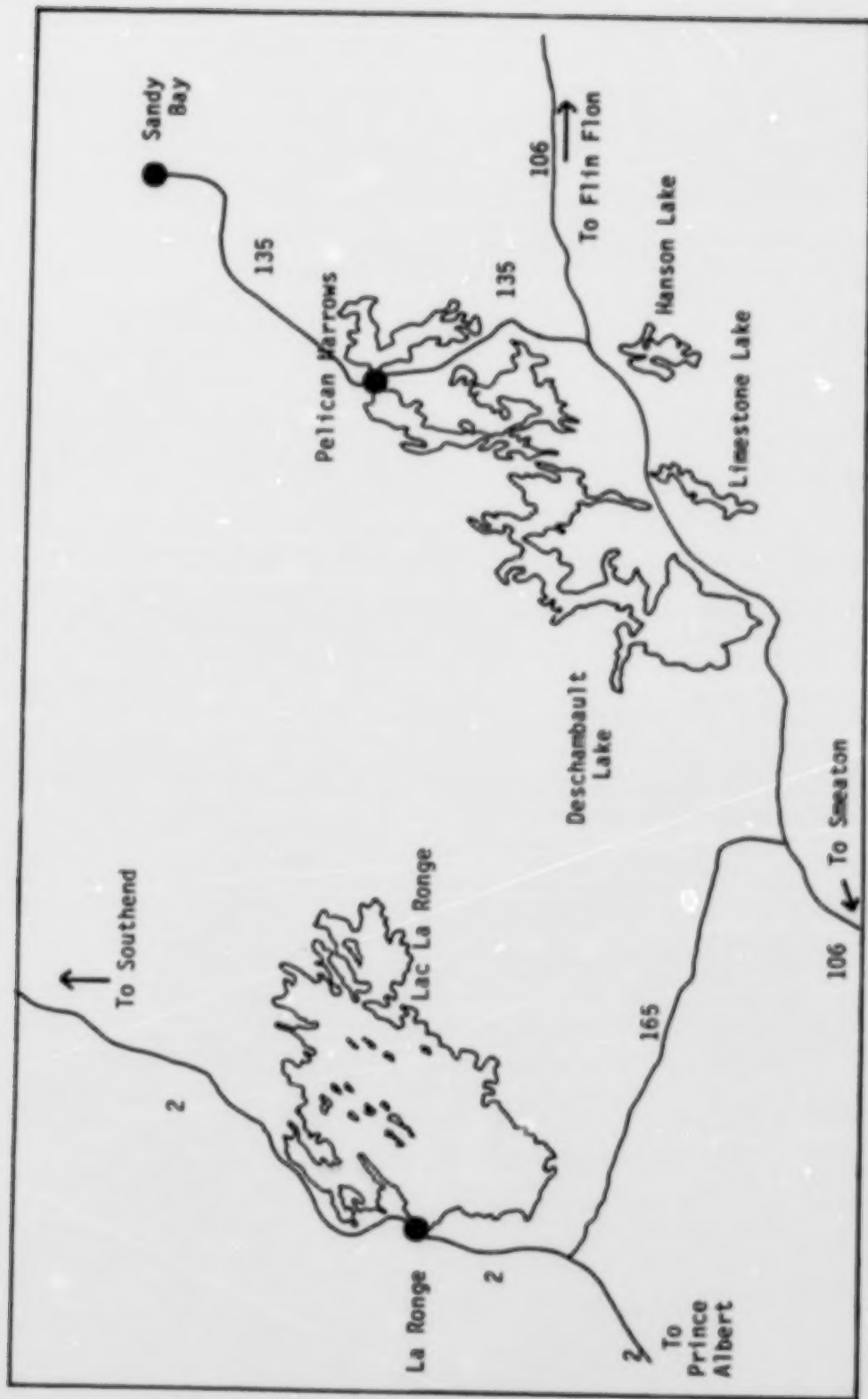


Fig. 1. Schematic diagram showing the relative locations of Limestone and Hanson Lakes.

Table 1. Distribution of depth zones in Limestone Lake (Adapted from Lane, 1967).

Depth Zone (m)	Area		Lake Volume	
	km ²	%	m ³ x 10 ⁶	%
0-5	28.14	80	68.34	60
5-10	7.03	20	45.56	40
Total	35.17		113.9	
Mean depth, m	3.2			
Maximum depth, m	7.0			

Table 2. Distribution of depth zones in Hanson Lake (Adapted from Sawchyn, 1967).

Depth Zone (m)	Area		Lake Volume	
	km ²	%	m ³ x 10 ⁶	%
0-5	19.11	45.6	1.59	47.8
5-10	10.35	24.7	0.87	26.1
10-15	5.87	14.0	0.47	14.1
15-20	2.77	6.6	0.25	7.7
20-25	2.85	6.8	0.11	3.3
25-30	0.67	1.6	0.03	0.9
30+	0.29	0.7		
Total	41.9		3.32	
Mean depth, m	7.94			
Maximum depth, m	32.8			

3. METHODS

The fish species in Limestone and Hanson lakes were sampled using a standard gang gill net. A standard gang is 276 m in length and has 46 m each of 3.8 cm, 5.1 cm, 7.6 cm, 10.2 cm, 12.7 cm, and 14.0 cm mesh sizes. It has long been accepted as the standardized measure for the evaluation of populations of large fish in Saskatchewan lakes. Ten standard gang gill nets were set in Hanson Lake in 1989, duplicating 10 of the 20 nets set in the study conducted in 1966 (Fig. 2). Due to time constraints, it was not possible to duplicate all 20 nets, nor was it possible to set the nets on the same dates as in the previous study. Similarly, three standard gang gill nets were set in Limestone Lake in 1989, replicating the locations, but not the dates of the 3 net sets of 1965 (Fig. 3). Each net remained set for approximately 24 hours after which time, it was lifted and picked.

Fork lengths (to the nearest millimeter) and weights (to the nearest gram) were recorded for all individuals of economically important species (i.e. walleye, lake whitefish, and northern pike). Sex was determined and state of maturity was defined as immature or mature. Stomach contents were inspected visually in the field. Other fish species, including cisco, perch, suckers, and burbot, were counted and maximum and minimum lengths and total weights were recorded. Individual lengths and weights were recorded for a representative sample.

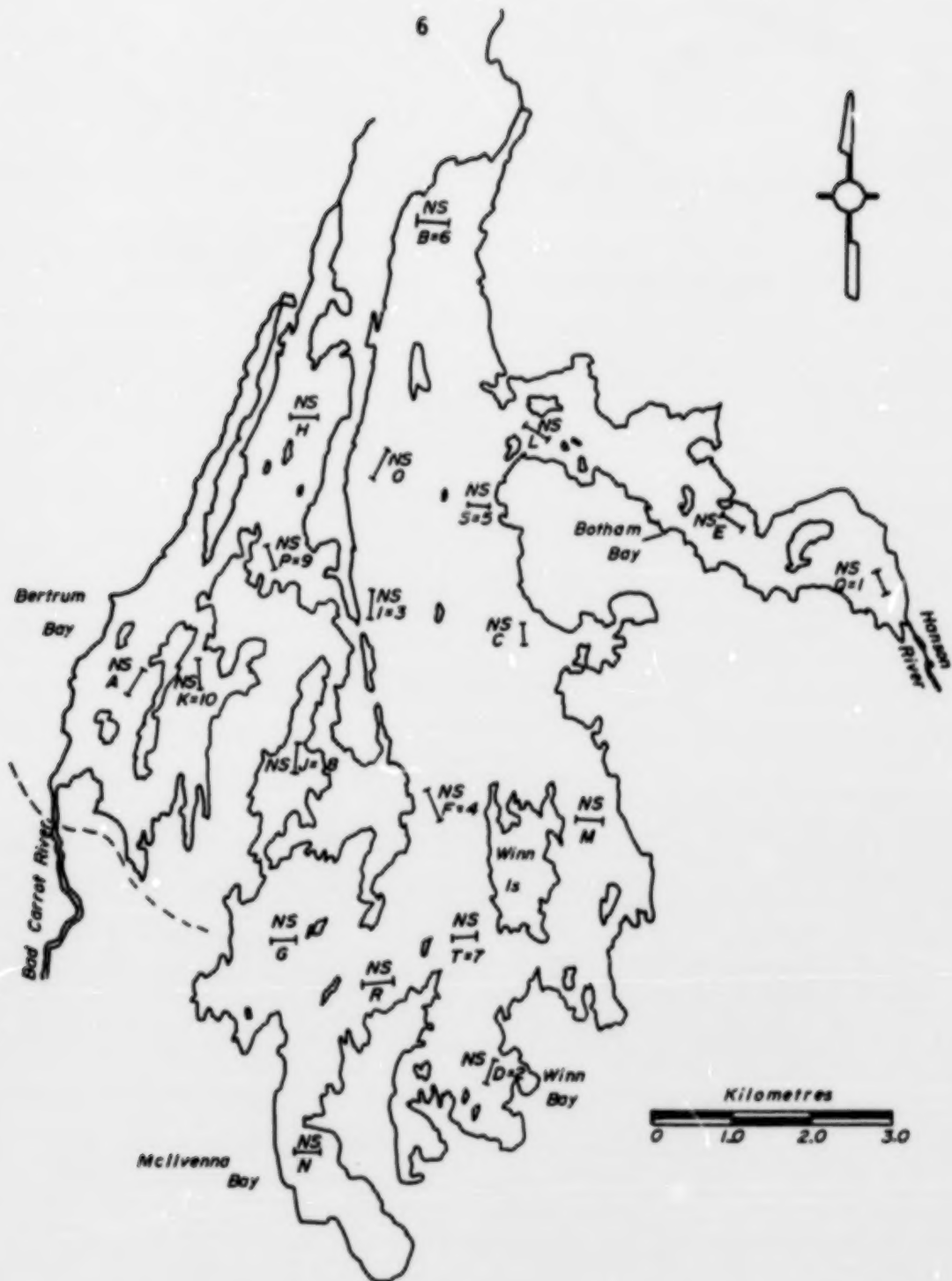


Fig. 2 Location of gillnet sets in Hanson Lake in 1966 (letter) and 1989 (number).

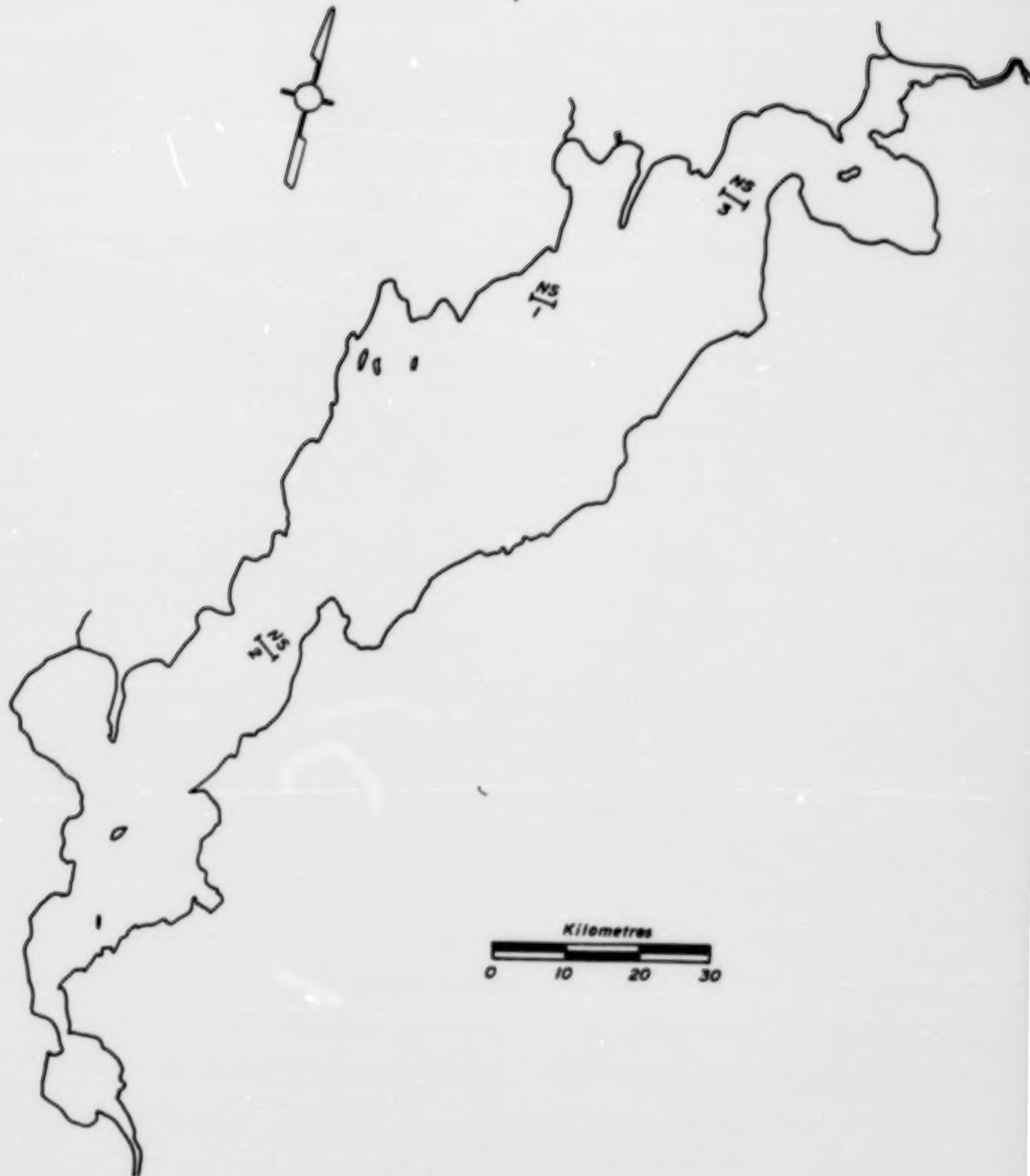


Fig. 3 Location of gillnet sets in Limestone Lake in 1965 and 1989.

Aging media, in the form of scales, were taken from a representative sample of recreationally and economically significant species. Procedures used in the preparation and analysis of these media are described in Musker (1985).

4. RESULTS

4.1 LIMESTONE LAKE

Species composition of the net catches varied between 1965 and 1989. In 1965, one lake whitefish and one burbot were found in the nets; in the current study, neither of these species were caught. The remaining 5 species caught during the 1965 study comprised the entire catch for the present study (Table 3). Fish abundance increased from 169 fish per net set in the earlier study to 309.7 fish per net set in 1989, due to the increased catch of walleye and cisco in the nets in that year. Numbers of northern pike, yellow perch, and common white suckers caught in the nets were not different between years.

Relative abundance of species in Limestone Lake has also changed between years. Walleye were the fish most frequently taken from the gill nets in 1989 and comprised 40% of the total catch for that year (Table 3). They were followed, in order of abundance, by ciscoes, common white suckers, northern pike, and yellow perch. The 1965 data show that common white suckers dominated the gillnet catch in that year, followed by walleye, northern pike and cisco and yellow perch.

Table 3. Summary of fish species caught in 3 gill nets in Limestone Lake in 1989 and 1965. (Wt. = weight in kg).

Species	1989		1965	
	No.	Wt.	No.	Wt.
Common white sucker <i>Catostomus commersoni</i>	218 (23.7)*	103.5 (21.0)	257 (51.0)	296.7 (67.8)
Cisco <i>Coregonus artedii</i>	247 (26.8)	91.9 (19.4)	43 (8.5)	24.8 (5.7)
Lake whitefish <i>Coregonus clupeaformis</i>	0 (0)	0 (0)	1 (0.2)	1.9 (0.4)
Northern pike <i>Esox lucius</i>	86 (9.0)	75.1 (15.0)	81 (16.0)	50.7 (11.6)
Burbot <i>Lota lota</i>	0 (0)	0 (0)	1 (0.2)	1.3 (0.3)
Yellow perch <i>Perca flavescens</i>	7 (0.8)	0.9 (0.2)	32 (6.3)	5.1 (1.2)
Walleye <i>Stizostedion vitreum</i>	369 (40.0)	223.5 (45.0)	92 (18.1)	50.4 (12.9)
Total	927	494.5	507	430.8
No./net set	309	164.8	169	143.6

* Percentage of total catch for the year.

Although fish numbers showed an 82% increase between studies, total catch weight increased by only 27% (Table 3). In both years, weight contribution of a species to the total catch weight reflected the abundance of that species.

WALLEYE

The number of walleye caught in gill nets in 1989 increased by 300% over that caught in 1965 (Table 3). The 1989 population was not only larger but was made up of larger fish, with the greatest portion of the catch being between 36 cm and 42 cm in fork length (Fig 4). In 1989 the average walleye was 37.4 cm in fork length and weighed 605.7 g (Table 4). Sizes ranged from 16.1 cm to 53 cm in fork length and weights from 45 g to 1575 g. In the earlier study, fork lengths ranged from 15.2 cm to 48.3 cm with a mean of 33.7 cm. Weights ranged from 28 g to 1304 g with a mean weight of 547.2 g.

In the current study, several age classes of walleye were represented in the gillnet catches. Ages ranged from 1 to 12 years with the majority of the population falling into the 5 to 8 year age groups. In the earlier study no fish older than 8 years were caught and the single largest age class was comprised of 3 year olds (Fig 5). The abundance of older, larger fish is reflected in the reduced growth rate displayed by fish from the current population, when compared to fish caught in 1965.

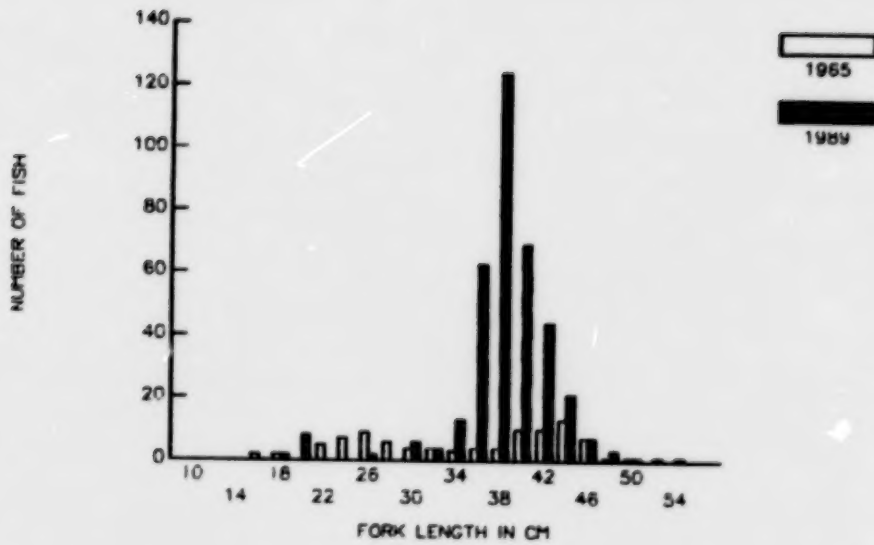


Fig. 4. Length frequency distributions of walleye caught in 3 gill nets in Limestone Lake in 1989 (n=369) and 1965 (n=92).

Table 4. Length weight data for four fish species caught in 3 gill nets in Limestone Lake in 1965 and 1989.

Species		1965		1989	
		Length (cm)	Weight (g)	Length (cm)	Weight (g)
Common white sucker	Mean	41.6	1154.6	37.0	802.5
	Max	49.3	1843	45.5	1475
	Min	17	62	19.8	90
Cisco	Mean	29.4	577.6	26.8	409.8
	Max	39.6	1446	43.6	1350
	Min	14.5	48	14.4	40
Northern pike	Mean	45.8	625.6	50.5	874.5
	Max	62.2	1304	74.0	2060
	Min	25.9	108	19.4	60
Walleye	Mean	33.7	547.2	37.4	605.7
	Max	48.3	1304	53	1575
	Min	15.2	28	16.1	45

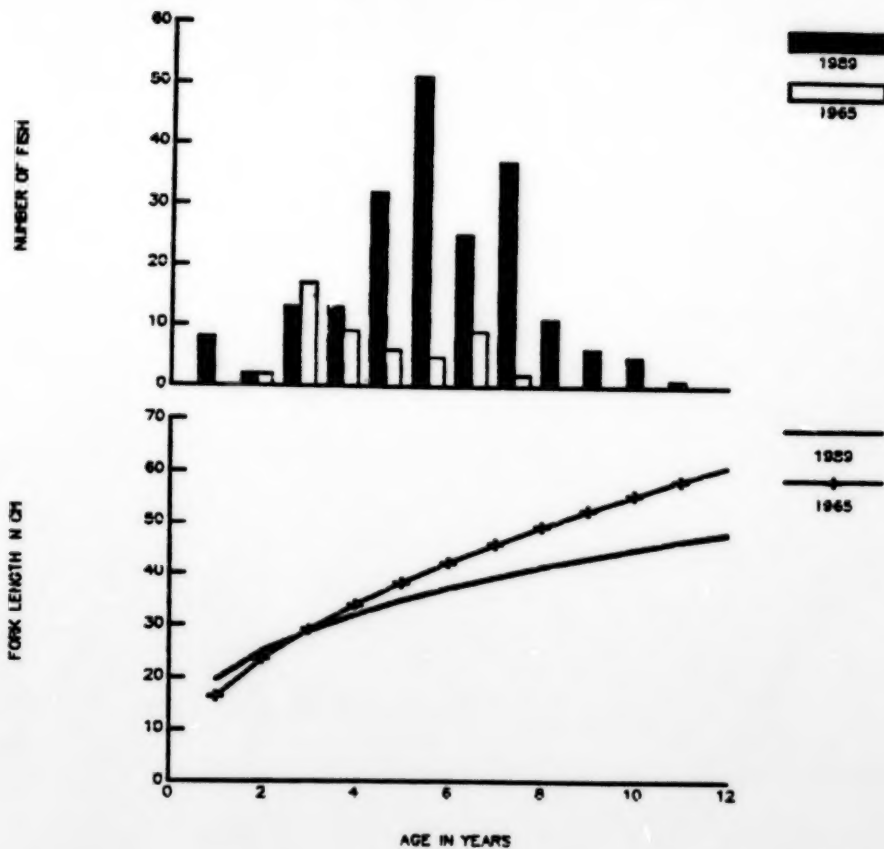


Fig. 5. Age distributions and growth of walleye caught in 3 gill nets in Limestone Lake in 1989 (n=204) and 1965 (n=50).

Data suggest that the majority of walleye in Limestone Lake achieve maturity at 5 years of age with an average fork length of 36.5 cm. Two thirds of the 5 year olds sampled were mature. Some males were mature as early as age 3, however, maturity could be delayed as late as 9 years for both males and females.

NORTHERN PIKE

Numbers of northern pike taken from gillnets in 1989 and 1965 were similar (Table 3). The length frequency distributions of fish revealed an increase in the number of large fish when compared to 1965 (Fig. 6). In the current study, fork lengths ranged from 19.4 cm to 74.0 cm with an average of 50.5 cm (Table 3). Average weight was 874.5 g with a minimum of 60 g and a maximum of 2060 g. Fish collected in the earlier study did not exceed 62.2 cm in fork length but were no smaller than 25.9 cm: mean fork length was 45.8 cm. In 1965, the average fish weighed 625.6 g with the smallest weighing 108 g and the largest having a weight of 1304 g.

Age distribution of pike ranged from 1 to 10 years, with the greatest portion of the catch (59%) falling into the 4 to 6 year age classes (Fig. 7). Only three fish were older than 7 years of age. The oldest pike caught in the 1965 study was only 6 years old and the majority (53%) of the fish were in the 3 to 4 year classes. Curves illustrating growth rates indicate only small differences between years,

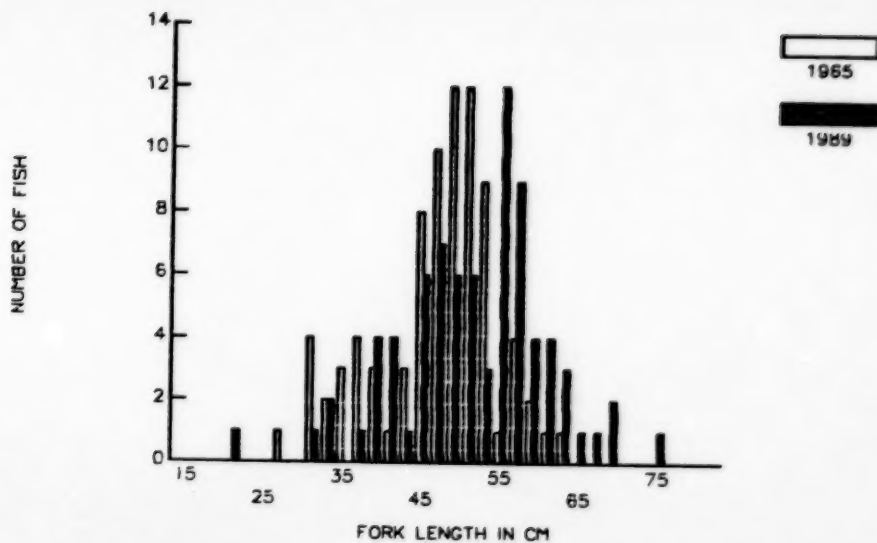


Fig. 6. Length frequency distributions of northern pike caught in 3 gill nets in Limestone Lake in 1989 (n=86) and 1965 (n=81).

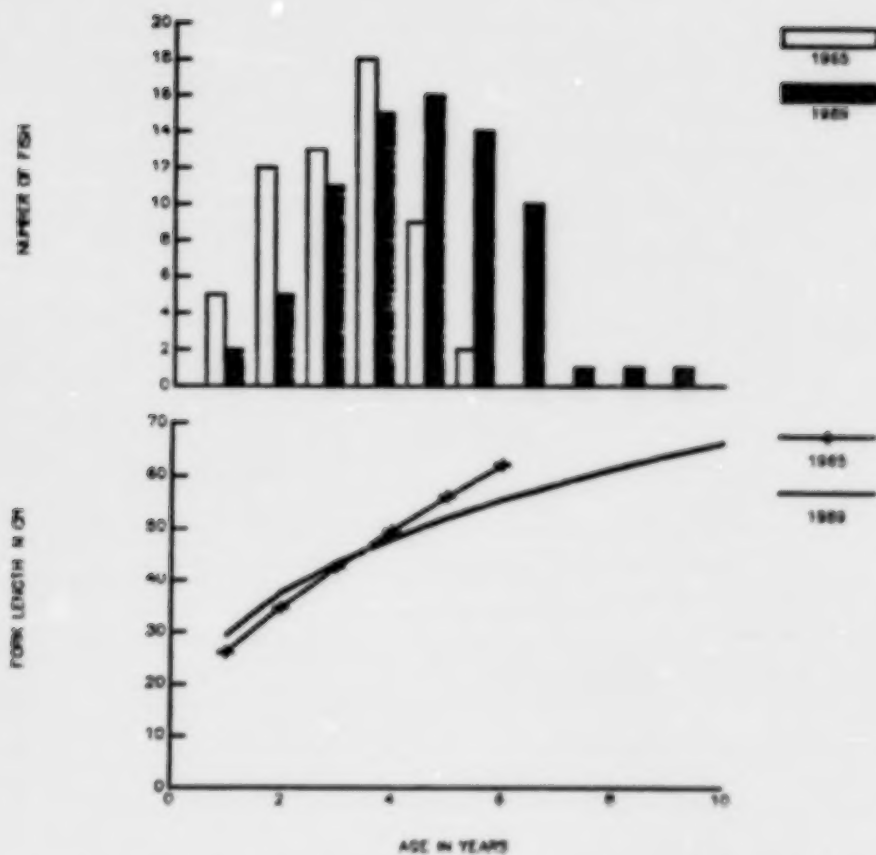


Fig. 7. Age distributions and growth of northern pike caught in 3 gill nets in Limestone Lake in 1989 (n=76) and 1965 (n=59).

and these are probably the result of different sample sizes for each age class.

CISCO

Similar to the walleye in Limestone Lake, ciscoes showed a dramatic increase (400%) in numbers between 1965 and 1989 (Table 3). The current population of ciscoes is characterized by two predominating size classes: those less than 20 cm in fork length, and those greater than 30 cm in fork length (Fig. 8). Overall, sizes ranged from 14.4 cm in fork length and 40 g to 43.6 cm and 1350 g (Table 3). The average fish was 26.8 cm and weighed approximately 410 g. In the previous study, the average cisco was 29.4 cm in fork length and weighed 577.6 g. The minimum fork length recorded was 14.5 cm with a weight of 48 g and the maximum was 39.6 cm with a weight of 1446 g.

UTILIZATION OF THE FISH RESOURCE

Commercial fishing on Limestone Lake dates back to 1941, at which time the quota was 11 350 kg and included lake whitefish only. However, records indicate that whitefish were incidental in the commercial catches, with cisco, on which there is no quota, being the primary target species. Walleye were included in the commercial limit in 1945, and in 1970 northern pike were added. The current quota of 6800 kg was established in 1966. In 1988, separate species quotas of 3550 kg for whitefish, 1000 kg for pike, and 2250 kg for walleye were

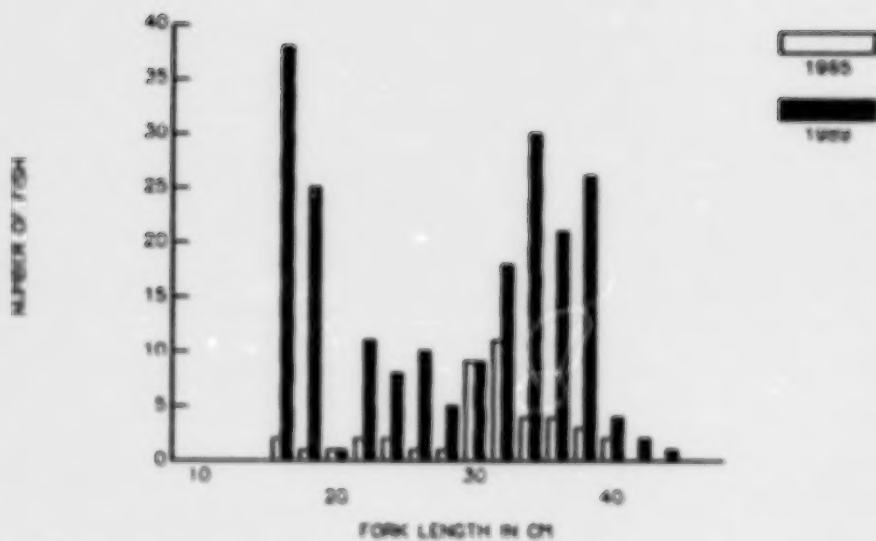


Fig. 8. Length frequency distributions of cisco caught in 3 gill nets in Limestone Lake in 1989 (n=247) and 1965 (n=43).

implemented. This was done in an effort to regulate incidental catches of whitefish and to protect the walleye stocks should a shift in target species occur following high incidences of "black spot" *Bolbophorus confusus* observed in the cisco population in the mid 1980's.

The allowable legal mesh size in Limestone Lake was originally set at 12.7 cm. This has changed several times over the last number of years and currently rests at 11.4 cm for all species.

Records for commercial production on Limestone Lake go back to 1959. Since that time, the number of licenses issued annually has ranged from 1 to 9, and total fish production has ranged from a low of 405 kg ($0.11 \text{ kg} \cdot \text{ha}^{-1}$) in 1986-87 to a high of 19 564 kg ($5.5 \text{ kg} \cdot \text{ha}^{-1}$) in 1964-65 (Appendix 1). An average of $2.32 \text{ kg} \cdot \text{ha}^{-1}$ was harvested annually over the last 30 years and was comprised of 3.6 % lake whitefish, 33.3 % walleye, 4.4% northern pike, and 58.7 % rough fish species, primarily cisco, but also included burbot, and suckers. Nine licenses were issued in 1989, however, production was nil.

Lake production reports also provide data on the domestic and native harvest since 1984. Although the records are based on estimates only, these harvests appear to have minimal impact on the total harvest. Murray and Clouthier (1986) suggested that actual records underestimate the true harvest by a minimum of a factor of 10. Taking this into account, total harvest from these fisheries from 1984 through to 1989 may have been 7300 kg which is equivalent to $0.42 \text{ kg} \cdot \text{ha}^{-1} \cdot \text{y}^{-1}$ over the 5 year period (Appendix 2). This catch was

comprised of 16% walleye, 11% pike, 38% cisco, and 34% other species (i.e. sucker, burbot).

Data on the recreational harvest from Limestone Lake is currently unavailable. However, it has been estimated that at least 1068 kg of walleye are taken by anglers annually (N. Dyck, pers. comm.). Assuming, based on creel data from Hanson Lake, that walleye are the preferred species of anglers and that one pike, with an average weight of 1.1 kg, to every two walleye, with an average weight of 0.5 kg, is kept, it can be estimated that 1175 kg of pike may also be harvested annually from Limestone Lake.

An estimate of the total annual harvest from Limestone Lake is given in Table 5. Based on the 30 years of available commercial harvest data, 5 years of domestic and native fishery data and the crude estimate for the recreational fishery, 12 125 kg of fish are harvested annually from Limestone Lake. This harvest is comprised of 34% walleye and 14% northern pike. The greatest portion of the pike harvest (69%) is taken by anglers. Over half (68%) of the walleye harvest is taken by commercial nets.

4.2 HANSON LAKE

Six species of fish comprised the gillnet catch in Hanson Lake in 1989. These same species were also caught in the 1966 study. Abundance increased from an average of 89.7 fish per net set in 1966 to 168.6 fish per net set in 1989 as a result of increased abundance of all

Table 5. Potential annual harvest (weight in kg) of the Limestone Lake fishery from commercial, native, and recreational sources.

	Whitefish	Walleye	N. Pike	Cisco	Other	Total
Commercial	280	2813	387	4960	0	8440
Native*	0	246	141	563	492	1442
Angler	0	1068	1175	0	0	2243
Total kg·ha ⁻¹	280 0.08	4127 1.2	1703 0.48	5523 1.6	492 0.14	12 125 3.5

* adjusted by a factor of 10 (Murray and Clouthier, 1986).

species (Table 6). Relative abundance remained unchanged between years. Cisco and lake whitefish dominated the gill net catch, comprising 40% and 30%, respectively, followed by common white sucker, walleye, pike and yellow perch.

WALLEYE

Walleye numbers in the gillnet catch increased by only 3% between study years (Table 6). The length frequency distributions of this species indicate that in both studies, the majority of fish were between 35 cm and 45 cm in fork length. In the earlier study, the remaining portion of the catch tended to be smaller while in the current study, there were a few larger fish but even fewer smaller ones (Fig. 9).

In 1989, the average walleye had a fork length of 39.3 cm and weighed 948 g (Table 7). The largest was 67.8 cm in length and weighed 3700 g. In the previous study, the largest walleye caught was less than 50 cm in fork length and weighed only 1276 g, but the average size was 36.8 cm and 607 g.

Ages of walleye ranged from 1 to 13 years of age (Fig. 10). The majority of the population fell into the 5 year age class. The growth rate displayed was fairly rapid, averaging 4.5 cm per year in the first 5 years of life. Eighty percent of the 5 year olds sampled were mature (average fork length was 38.8 cm), and all the 6 year olds were mature (average fork length was 40.1 cm).

Table 6. Summary of fish species caught in 10 gill nets in Hanson Lake in 1989 and 1966. (Wt. = weight in kg).

Species	1989		1966	
	No.	Wt.	No.	Wt.
Common white sucker <i>Catostomus commersoni</i>	298 (18.0)*	118.1 (20.6)	139 (15.0)	71.2 (17.0)
Cisco <i>Coregonus artedii</i>	682 (40.0)	151.3 (26.4)	354 (39.0)	66.2 (16.0)
Lake whitefish <i>Coregonus clupeaformis</i>	501 (30.0)	144.6 (25.2)	254 (28.0)	135.4 (32.0)
Northern pike <i>Esox lucius</i>	94 (6.0)	89.2 (15.6)	52 (6.0)	89.5 21.0)
Yellow perch <i>Perca flavescens</i>	11 (1.0)	0.6 (0.)	1 (0.)	0.04 (0.)
Walleye <i>Stizostedion vitreum</i>	100 (6.0)	89.6 (12.0)	97 (11.0)	58.9 (14.0)
Total	1686	573.4	897	421.1
No./net set	168.6	57.3	89.7	42.1

*Percentage of total catch for the year.

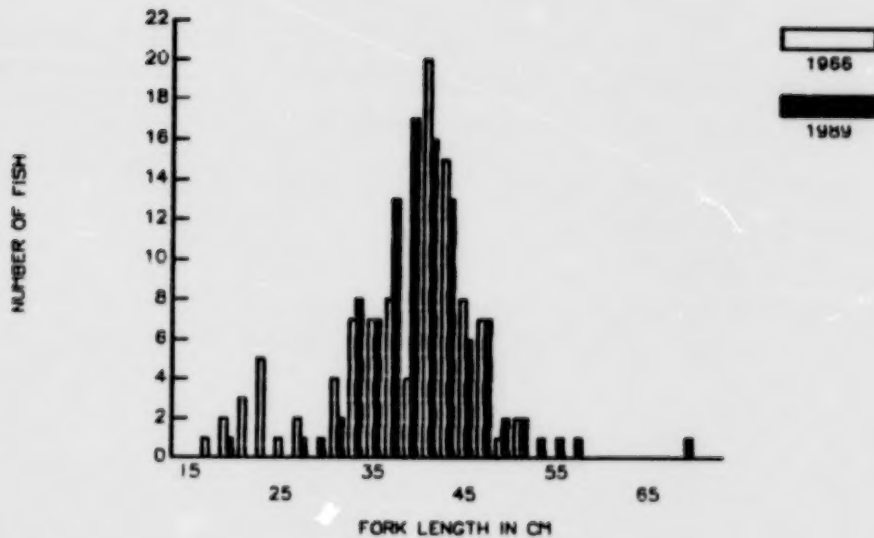


Fig. 9. Length frequency distributions of walleye caught in 10 gill nets in Hanson Lake in 1989 (n=100) and 1966 (n=97).

Table 7. Length weight data for four fish species caught in 10 gillnets in Hanson Lake in 1966 and 1989.

Species		1966		1989	
		Length (cm)	Weight (g)	Length (cm)	Weight (g)
Cisco	Mean	22.47	187.1	26.24	238.3
	Max	37.8	879	34.1	500
	Min	6.1	28	14.8	37
Lake whitefish	Mean	32.4	533.1	28.7	288.7
	Max	52.3	1956	52.7	950
	Min	14.7	34	15.5	40
Northern pike	Mean	59.9	1724.5	48.77	948.7
	Max	78.5	3878	78.2	3500
	Min	41.4	496	33.7	250
Walleye	Mean	36.8	607.9	39.3	948.7
	Max	49.8	1276	67.8	3700
	Min	16.3	28	19	65

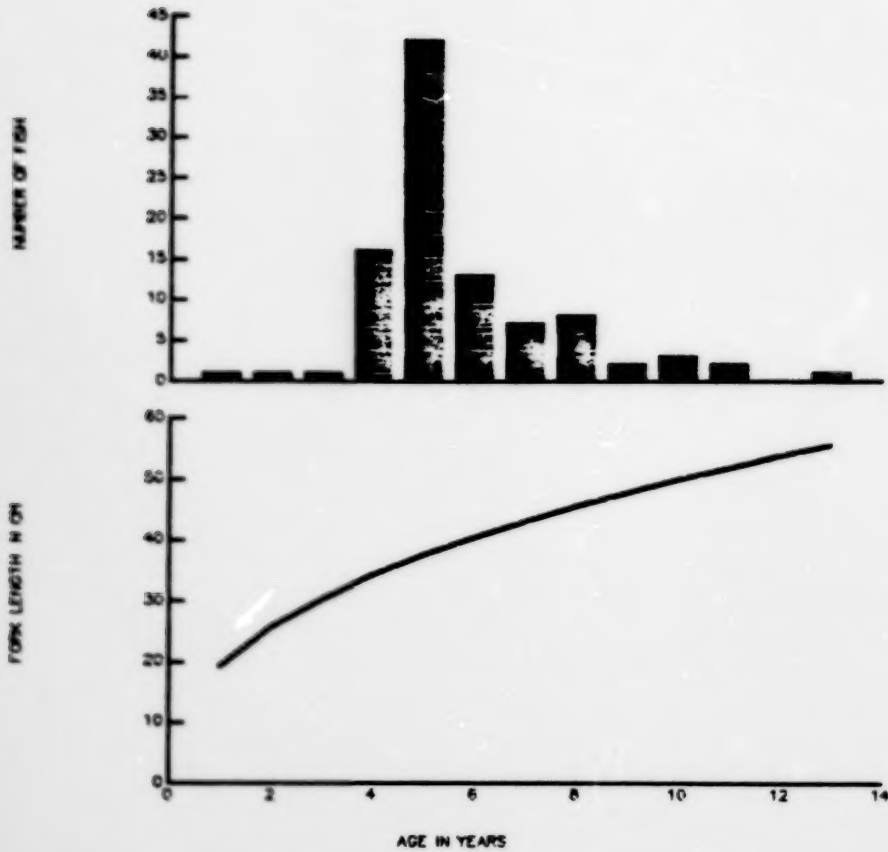


Fig. 10. Age distribution and growth of walleye caught in 10 gill nets in Hanson Lake in 1989 (n=97).

NORTHERN PIKE

The abundance of northern pike in the gillnet catches increased by approximately 80% in 1989 compared to 1966. The majority of fish caught were less than 54 cm in fork length (Fig. 11). The largest pike caught had a fork length of 78.2 cm and weighed 3500 g (Table 7); the smallest was 33.7 cm and 250 g. In 1966, the bulk of the pike catch was comprised of fish larger than 54 cm (Fig. 11). As in the current study, the maximum size was recorded at 78.5 cm but this fish weighed 3878 g (Table 7). The smallest pike had a fork length of 41.4 cm and weighed 496 g.

Analysis of aging material revealed the pike population in Hanson Lake to be comprised of fish no older than 7 years of age (Fig. 12). The majority of fish were 3 and 4 years of age. Growth was rapid with annual increments averaging 5.9 cm per year. Sexual maturity occurred as early as 1 year of age for some males. All fish 4 years of age were mature and 64% of the 2 year olds were mature.

LAKE WHITEFISH

The number of lake whitefish caught in gill nets in 1989 was double that caught in the earlier study conducted in 1966 (Table 6) indicating a significant increase in abundance of this species. The length frequency distributions were similar between years, with the majority of fish ranging in size from 28 cm to 34 cm in fork length.

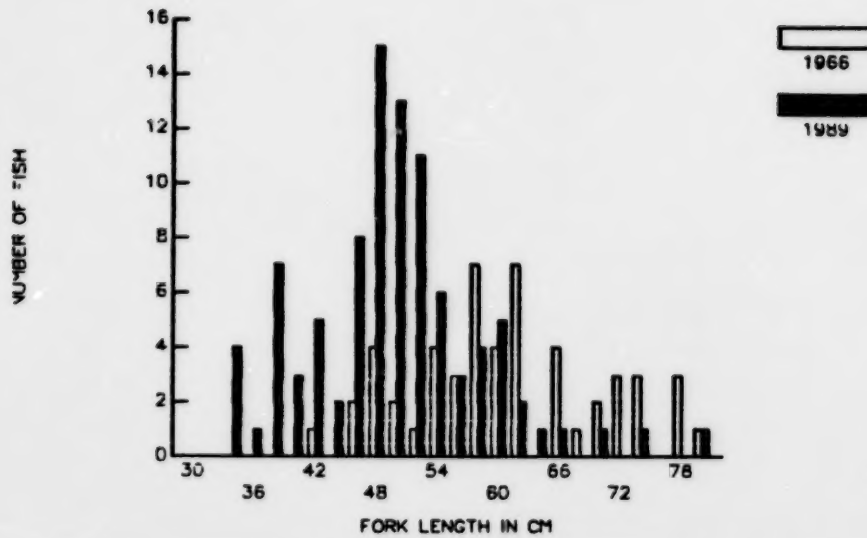


Fig. 11. Length frequency distributions of northern pike caught in 10 gill nets in Hanson Lake in 1989 (n=94) and 1966 (n=52).

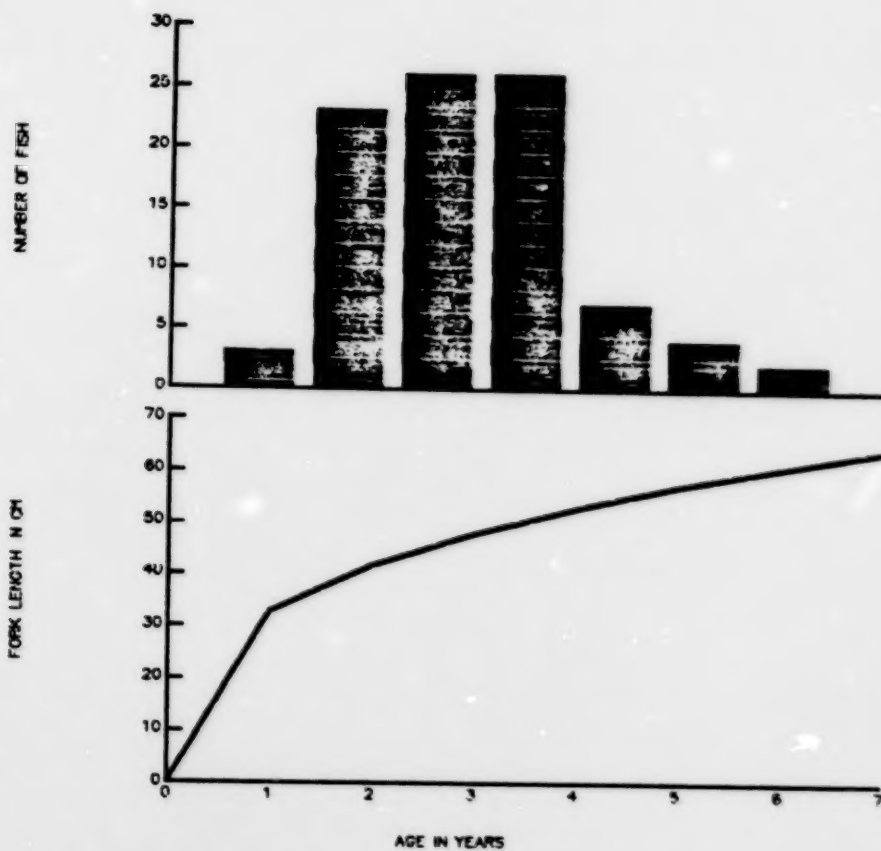


Fig. 12. Age distribution and growth of northern pike caught in 10 gill nets in Hanson Lake in 1989 (n=94) and 1966 (n=52).

(Fig. 13). Maximum recorded fork lengths were similar between years (Table 7), however comparative weights were substantially different. Overall, lake whitefish caught in 1989 were smaller than those taken in the earlier study, averaging 28.7 cm in fork length and 288 g in contrast to the previously observed average of 32.4 cm and 533 g.

The current population of whitefish in Hanson Lake is comprised of relatively young fish. Age classes ranged from 2 to 9 years, with 4 and 5 year old fish dominating the catch (Fig. 14). Results indicate that sexual maturity is achieved by age 3 (average fork length of 25.9 cm), as only 11% of the 3 year olds sampled were immature. The incremental growth up to 3 years of age averaged 2.5 cm per year but dropped off to 1.6 cm per year once saturation was achieved. Overall, the growth within this population is slow. Aging data from the previous study were unavailable for comparison.

CISCO

Cisco numbers in the gillnet catches showed an increase of 104% over the numbers caught in 1966. In the earlier study, fork lengths were recorded from every fish caught, and ranged from 6.1 cm and 28 g to 37.8 cm and 879 g (Table 7). The average fish measured at 22.5 cm and weighed 187 g. Due to time constraints, not all the ciscos caught in 1989 were measured and weighed. This may have created a sampling bias in that only the larger, more easily handled fish were measured. In any event, fork lengths, taken from 176 of the 682 cisco

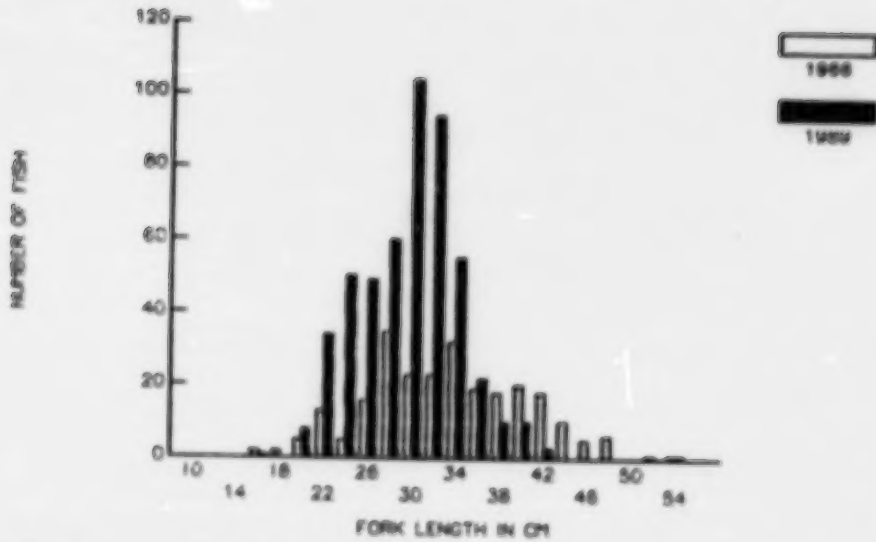


Fig. 13. Length frequency distributions of lake whitefish caught in 10 gill nets in Hanson Lake in 1989 ($n=501$) and 1966 ($n=254$).

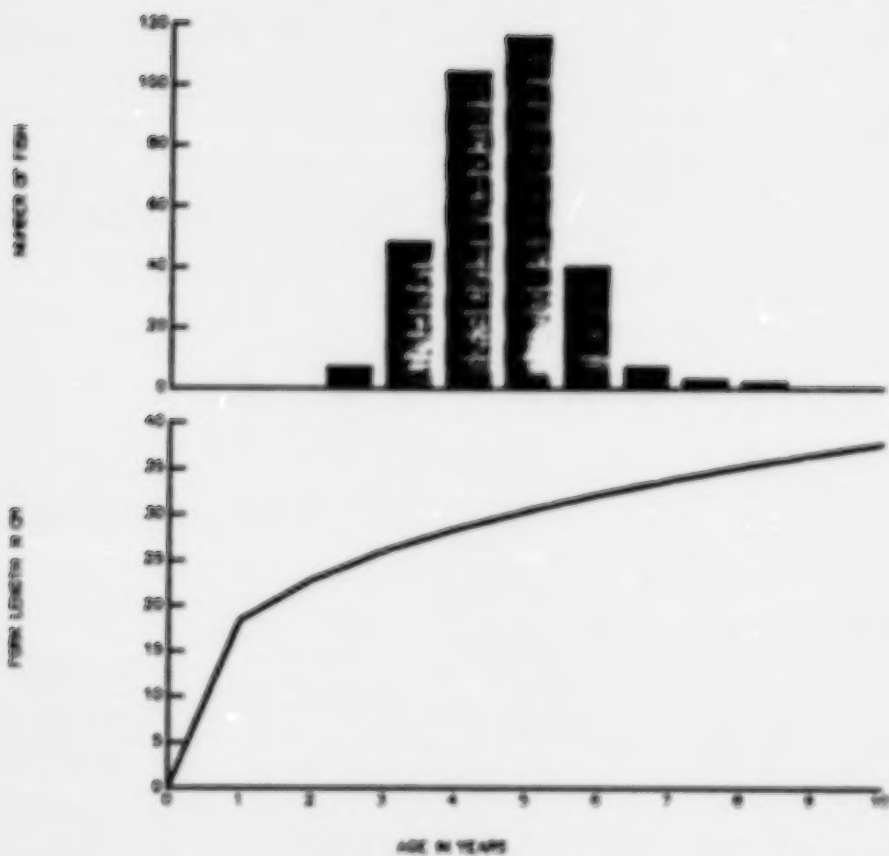


Fig. 14. Age distribution and growth of lake whitefish caught in 10 gill nets in Hanson Lake in 1989 (n=323).

caught, indicated the current population is made up of fish larger than 23 cm (Fig. 15), with the average fork length being 26.2 cm (Table 7). The largest cisco had a fork length of 34.1 cm and weighed 500 g while the smallest was 14.8 cm weighing 37 g.

UTILIZATION OF THE FISH RESOURCE

Commercial fishing on Hanson Lake dates back to 1928, and has traditionally been light. For several years prior to 1941, fishing effort was minimal and commercial production was below 10 000 kg. In an attempt to stimulate the fishery, the first regulated quota of 13 600 kg, using a 12.7 cm mesh size, was established in 1941 and included whitefish and walleye. The result was an increase in licenses issued and a production that exceeded the quota. Although there was no recorded fishing between 1944 and 1950, the quota was reduced to 9 080 kg, and then increased to 11 350 kg within that time period. In 1952, annual production reached its peak at 23 529 kg. In 1953, the quota for Hanson Lake was increased to 22 700 kg and remained there for the next 14 years. The current quota of 18 100 kg was implemented in 1966 in conjunction with a reduction in legal mesh size, which would allow for improved harvest of walleye stocks. Northern pike were included in the quota in 1970 and in 1983, separate species quotas were introduced to protect the commercial fishery from criticism from the increasing sport fishery on the lake. Presently, the commercial fishing

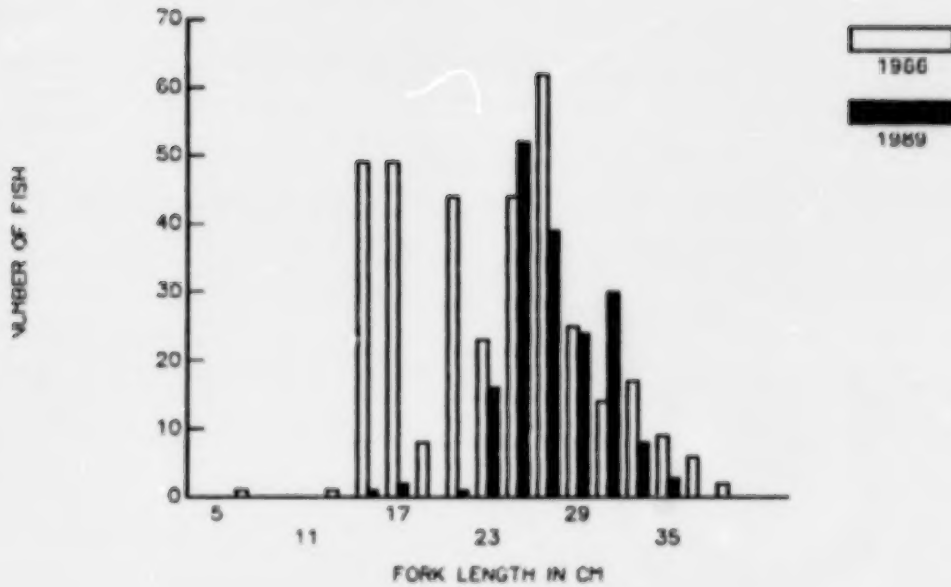


Fig. 15. Length frequency distributions of cisco caught in 10 gill nets in Hanson Lake in 1989 (n=176) and 1966 (n=354).

quota is 13 600 kg for lake whitefish, and 450 kg each for walleye and northern pike.

The number of commercial fishing licenses issued annually for Hanson Lake has ranged from 1 to 11, however historical records are punctuated with years of no recorded fishing effort (Appendix 3). Over the last 62 years, only 35 years have produced with the most constant fishing effort occurring between 1958 and 1973. During this time the lake was fished every year. Over the last 20 years, there has generally been only one licensed operator on the lake and there has only been 11 years of production recorded in that time. Production has been well below the quota, averaging 3226 kg annually ($0.77 \text{ kg}\cdot\text{ha}^{-1}$) comprised of 78% whitefish, 9% walleye, 12% northern pike, and 1% other species.

Hanson Lake also supports a native fishery. Records of harvest, similar to those for Limestone Lake, are available only as far back as 1984. Total native harvest (adjusted) between 1984 and 1989 may have been 5 270 kg ($0.25 \text{ kg}\cdot\text{ha}^{-1}$) comprised of 32% whitefish, 29% each of pike and walleye, and 10% of other species such as sucker and burbot (Appendix 2). This fishery appears to have little impact on the total harvest from Hanson Lake.

Information on angler harvest on Hanson Lake is shown in Table 8 and was obtained from the outfitters operating on the lake between 1979 and 1984. Based on present guidelines using guest capacity, occupancy rate, and length of stay, the potential angler

Table 8. Angler harvest on Hanson Lake between 1979 and 1984 (weight in $\text{kg} \times 10^3$).

Year	No. Pike	Weight Pike	No. Walleye	Weight Walleye	Total No.	Total Weight
1979	1206	3.29	3342	3.9	4548	7.19
1980	1953	5.27	4045	4.79	5998	10.06
1981	2114	6.29	2323	2.63	4437	8.92
1982	1436	3.88	1043	1.17	2479	5.05
1984	810	0.70	482	0.28	1292	0.98
Total	7519	19.43	11235	12.77	18754	32.20
Average kg/ha/yr	1503.8	3.89 0.93	2247	2.55 0.61	3750.8	6.44 1.54

harvest of walleye was estimated at $1.82 \text{ kg} \cdot \text{ha}^{-1}$ (Hartwig, 1985). The estimate for pike was $2.44 \text{ kg} \cdot \text{ha}^{-1}$. These estimates appear to be somewhat inflated as actual data indicate that an average of only $0.61 \text{ kg} \cdot \text{ha}^{-1}$ (2555 kg) of walleye and $0.93 \text{ kg} \cdot \text{ha}^{-1}$ (3 897 kg) of pike were taken yearly by anglers staying at the outfitter camp. Additional information available from 1987 gut can counts suggests that annual angler harvest may be closer to $0.67 \text{ kg} \cdot \text{ha}^{-1}$ (2 800 kg) of walleye and $1.05 \text{ kg} \cdot \text{ha}^{-1}$ (4400 kg) of pike.

Potentially, average annual harvest from Hanson Lake is near 11 430 kg (Table 9). This is comprised of 44% pike, 30% walleye, and 25% whitefish. It was estimated that 63% of the total harvest and 85% of the gamefish harvest was taken by the recreational fishery.

Table 9. Potential annual harvest (weight in kg) of the Hanson Lake fishery from commercial, native, and angler sources.

	Whitefish	Walleye	N. Pike	Other	Total
Commercial	2547	290	387	2	3226
Native*	335	293	293	84	1005
Angler	0	2800	4400	0	7200
Total	2882	3383	5080	86	11 431
kg·ha ⁻¹	0.69	0.80	1.21	-	2.73

* adjusted by a factor of 10 (Murray and Clouthier, 1986)

5. DISCUSSION

The Limestone Lake and Hanson Lake fisheries are comprised of 5 and 6 species of large fish, respectively. Compared to other lakes throughout the province, Limestone Lake has a relatively high abundance of game fish (151.6 game fish/net) which is comprised primarily (81%) of walleye (Table 10). Hanson Lake, on the other hand, has a relatively low abundance of game fish (19.4 game fish/net).

Limestone Lake has an excellent population of walleye, having an extremely high abundance in comparison to other Saskatchewan

waterbodies (Table 10). The increase in abundance of these fish since 1965 is probably the result of separate species quotas in the commercial fishery in conjunction with an under developed recreational fishery. This has resulted in a reduced growth rate and an abundance of small-size older fish. In addition, a large portion of the population is comprised of mature fish, which, while not trophy size, are of a desirable size to anglers.

In contrast, the walleye population in Hanson Lake has remained unchanged in terms of abundance, since the 1966 study. Compared to other lakes in the province, Hanson Lake is low in walleye numbers (Table 10). The current walleye population is comprised of fast growing fish which can potentially reach a size desired by anglers before attaining maturity. (It is not known, however what portion of the population is taken by anglers). The relatively large sizes in conjunction with a lack of older fish in the population suggests that Hanson Lake walleye are heavily utilized.

Outfitters reported a decrease in walleye harvest in Hanson Lake between 1979 and 1984. The Bad Carrot River and Bertrum Bay are significant areas for walleye and pike, particularly in the spring. The reported decrease in walleye harvest could be the result of closure of these areas to angling between March 1 to May 31.

Bad Carrot River was the site of an annual walleye spawning camp between 1975 and 1984. In compliance with a stocking policy initiated in 1977, 10% of all spawn taken is returned to the donor lake

as fry to maintain stocks. Appendix 4, showing the numbers of walleye spawned in each year, indicates the spawning population actually increased between 1977 and 1984. In addition, the average ounces of eggs per female spawned changed little over the 10 years, indicating a relatively stable size to age ratio within the population (R. Kidd, pers. comm.)

The northern pike population in Limestone Lake is fair and rates well, in terms of abundance, when compared to other Saskatchewan lakes (Table 10). Compared to 1965, pike abundance, has remained unchanged. The age structure and growth characteristics indicate that separate species quotas, implemented in 1986, have resulted in some improvement in the pike population. Still, there are few large fish present and their abundance makes angling opportunities less favorable than those for walleye in the same lake.

The northern pike in Hanson Lake are young, rapidly growing fish which achieve maturity at an early age. Although abundance appears to have increased since the previous study, there are few old, large fish present indicating that once fish reach a size preferred by anglers, they are quickly harvested. The abundance of this species, when compared to 7 other lakes throughout Saskatchewan is only greater than the heavily fished Dore Lake (Sawchyn, 1987; Table 10).

Ciscoes, not lake whitefish, have traditionally been the target species in the Limestone Lake commercial fishery. In the mid 1980s, a high incidence of black spot in the flesh of ciscoes lowered

Table 10. Comparison of walleye, northern pike (gamefish) and lake whitefish abundance, per standard gang of gillnet, in Limestone and Hanson lakes in relation to other Saskatchewan waterbodies.

Waterbody	No. of Walleye/net	No. of Pike/net	No. of Whitefish/net	Total gamefish/net	Source
Limestone L.	123	28.6	0	151.6	present study
Montreal L.	50	40	9	90	Merkowsky and Sawchyn 1988
Pinehouse L.	48	23	17.2	71	L'law 1988
Guilloux	45	19	42	66	L'law 1986
Jackfish L.	3.8	43.5	12.9	47.3	Durbin 1980
Jan L.	15	21	18.9	36	Gloutney 1990
Hanson L.	10	9.4	50.1	19.4	present study
Dore L.	1	6	15.2	7	Sawchyn 1987

the market quality. This stimulated a concern with regard to the effect a switch in species preference by commercial fishermen would have on game fish, particularly walleye. The result was the implementation of separate species quotas. Commercial fishing effort in Limestone Lake ultimately dropped off allowing the cisco population to flourish. Because cisco is a preferred prey species of pike, this increase in the cisco population has probably had positive ramifications with regard to the previously discussed trend of improvement observed in the pike population.

In Jan Lake, abnormal growth variations (Johnson, 1967), and the presence of small mature ciscoes and large immature ciscoes (Gloutney, 1990) led to the conclusion that more than one species was present. Similarly, the two distinct size ranges within Limestone's cisco population may indicate the presence of two species.

LAKE PRODUCTIVITY

Maximum sustainable yields for Limestone and Hanson lakes were determined based on Ryder's (1965) morphoedaphic index (MEI). Using the total dissolved solids value of $140 \text{ mg}\cdot\text{L}^{-1}$ determined by Lane (1967), the MEI for Limestone Lake is 43.75. The maximum sustainable yield for all species was estimated at $6.48 \text{ kg}\cdot\text{ha}^{-1}$ or 22 800 kg. Using percent composition of total catch by weight for each gamefish species, the MSY for walleye was estimated at $2.84 \text{ kg}\cdot\text{ha}^{-1}$ (10 000 kg), and at $0.97 \text{ kg}\cdot\text{ha}^{-1}$ (3400 kg) for pike. This MSY for walleye shows a

substantial increase over the $1.1 \text{ kg}\cdot\text{ha}^{-1}$ estimated in 1986 (based on provincial allocation procedures where no other estimate is known) and is probably the result of decreased commercial harvest effort and a subsequent decrease in walleye harvest. Maximum sustained yield for lake whitefish could not be determined as none were caught in test nets.

Maximum sustained yield for Hanson Lake was similarly determined. The total dissolved solids value used was $90 \text{ mg}\cdot\text{L}^{-1}$ (Sawchyn, 1967) and gave an MSY estimate that was approximately equal to half the MSY for Limestone Lake. The MEI value of $3.24 \text{ kg}\cdot\text{ha}^{-1}$ (13 600 kg), derived from current test net data, translates into $0.83 \text{ kg}\cdot\text{ha}^{-1}$ (3500 kg) of whitefish, $0.38 \text{ kg}\cdot\text{ha}^{-1}$ (1600 kg) for walleye and $0.50 \text{ kg}\cdot\text{ha}^{-1}$ (2100 kg) for pike. In 1985, the MSYs for game fish were estimated at $1.68 \text{ kg}\cdot\text{ha}^{-1}$ (7000 kg) and $1.45 \text{ kg}\cdot\text{ha}^{-1}$ (6 000 kg), respectively (Hartwig, 1985). Population characteristics, as described earlier, indicate that both the pike and walleye stocks in this lake are currently being fished in excess. This probably accounts for the differences in MSY between 1985 and now.

MANAGEMENT IMPLICATIONS

Comparison of total harvest estimates and maximum sustained yield in Limestone Lake, suggest this lake is not being utilized to its full potential. The walleye stocks appear well able to cope with the current pressures exerted on them. Records show that approximately 4 000 kg of walleye are taken annually from this lake. The MSY suggests

the current population could be harvested at a level of 10 000 kg annually. Decreasing the density of the walleye population would allow for increased growth of the fish, and subsequently make available a more desirable angling-sized fish. Similarly, the northern pike population is also being underutilized. The yearly harvest now stands at approximately 1700 kg. The maximum sustained yield estimate indicates that the population could withstand a harvest closer to 3400 kg. The remaining species (cisco) could be harvested at a rate of 9400 kg per year, and be within the limits of the estimated MSY.

In Hanson Lake, maximum sustained yields estimate a total allowable harvest not in excess of 13 600 kg comprised of 1600 kg of walleye, 2100 kg of pike, 3500 kg of whitefish, and 6400 kg of other species. Since the introduction of separate species quotas in 1983, the annual harvests of pike and walleye in the commercial fishery have remained well within their 450 kg limits. Due to the heavy pressures placed on these species from anglers, any expansion of the recreational fishery on Hanson Lake should be discouraged.

Current harvest records indicated that whitefish harvest is well below the suggested MSY of 3500 kg. The result is a stunted population wherein fish are abundant but growth is slow and average size is too small to be caught in commercial mesh. An increase in harvest would benefit the population, and ultimately the commercial fishery, by promoting growth in the remaining portion of the population. A reduction in mesh size to achieve this is not feasible, however, as it

would also impact on the already overharvested walleye and pike populations. The current quota allows for 13 600 kg of whitefish to be harvested annually. Any change to the limit at this time will have no beneficial effect on the whitefish stocks.

CONCLUSIONS AND RECOMMENDATIONS

Testnetting studies conducted on Limestone and Hanson lakes during the summer of 1989 revealed that five species of large fish comprised the Limestone fishery with walleye comprising the largest single portion (45%) of the catch by weight. Six species made up the Hanson Lake fishery with lake whitefish and cisco forming over half the gillnet catch.

Walleye are abundant in Limestone Lake and the population can withstand a controlled expansion of the fishery. In contrast, the walleye population in Hanson Lake is being overharvested by 1800 kg annually, based on maximum sustained yield values.

Pike in Limestone Lake appear to have responded positively to the separate species limits imposed in 1986, as well as to an increase in the cisco population. Although not as abundant as the walleye, the current population structure indicates a moderately abundant pike population. Pike in Hanson Lake have almost doubled in number since 1966 but, similar to the walleye in that lake, are being overfished by approximately 3 000 kg per year.

Cisco abundance within Limestone Lake has flourished since the early 1980's when high infestations of black spot, followed by the implementation of separate species quotas reduced the viability of the commercial effort. In response to this low commercial effort and a poorly developed recreational fishery, fish populations within Limestone Lake have done well.

The commercial fishery on Hanson Lake has been somewhat sporadic over the last 20 years. It has had minimal impact on the total annual harvest from the lake, resulting in a stunted population of lake whitefish. However, the angling effort is high and the annual production from the recreational fishery is in excess of the lake's ability to maintain gamefish populations. Efforts to improve whitefish populations for a viable commercial fishery must be tempered by the requirements for sustained walleye and pike populations.

RECOMMENDATIONS

1. There is room for expansion for both the recreational and commercial fishery in Limestone Lake.
2. Discourage future expansion of the gamefish fishery on Hanson Lake.
3. Retain spring closure of the Bad Carrot River and Bertrum Bay.
4. Terminate spawn removal from the Bad Carrot River for an indefinite period of time or increase the return rate of fry to the creek.
5. Retain the current quotas on the Hanson Lake commercial fishery.

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7. APPENDICES

Appendix 1. History of the commercial fishery production on Limestone Lake from 1959 to 1989 inclusive (weight in kilograms).

Year	Lake Whitefish	Walleye	Northern Pike	Other	Total	No. Licenses
1959-60	96	442	245	3392	4175	3
1960-61	123	1595	785	9760	12263	3
1961-62	758	3221	1901	11312	17192	3
1962-63	no fishing					
1963-64	99	7124	538	7485	15246	4
1964-65	142	11671	438	7313	19564	5
1965-66	39	8305	527	9422	18293	5
1966-67	-	5124	564	10700	16388	7
1967-68	79	3407	261	2117	5864	9
1968-69	30	2066	160	1363	3619	5
1969-70	-	3654	143	4187	7984	7
1970-71	75	5092	1098	2887	9152	5
1971-72	-	2481	-	-	2481	3
1972-73	3953	136	82	25	4196	3
1973-74	177	2463	189	231	3060	1
1974-75	142	2505	86	10856	13589	2
1975-76	807	1273	84	16424	18588	6
1976-77	1825	2207	492	6020	10544	5
1977-78	47	671	115	4446	5279	3
1978-79	no fishing					
1979-80	480	2434	1182	8405	12501	2
1980-81	140	1508	372	3625	5645	3
1981-82	6	4458	68	8080	12612	8
1982-83	4	3543	346	2951	6844	2
1983-84	-	2428	597	4697	7722	8
1984-85	1	2600	181	1103	2885	7
1985-86	-	1077	193	7188	8458	9
1986-87	-	23	7	375	405	2
1987-88	-	1231	230	1283	2744	2
1988-89	-	0	0	0	0	9
Total	9023	82739	10884	145647	247293	131
% total	3.6	33.3	4.4	58.7	100	
Average kg/ha	2.53	23.24	3.06	40.91	69.74	
kg/ha/yr	0.08	0.80	0.11	1.41	2.40	

Appendix 2. Harvest of the Indian permit and domestic fisheries on Limestone and Hanson lakes between 1984 and 1989.

Limestone Lake						
Year	Whitefish	Walleye	N. Pike	Cisco	Other	Total
1984-85	0	20	20	30	50	12
1985-86*	0	30	20	100	0	150
1986-87	0	20	20	0	200	240
1988-89	0	50	20	150	0	220
Total	0	120	80	280	250	730
Average	0	24	16	56	50	146
kg/ha/yr	0	0.007	0.004	0.016	0.014	0.042
Adjusted	0	0.07	0.04	0.16	0.14	0.42
Hanson Lake						
Year	Whitefish	Walleye	N. Pike	Cisco	Other	Total
1984-85	30	45	40	0	0	115
1985-86	21	16	23	0	52	112
1987-88	100	70	50	0	0	220
1988-89	20	20	40	0	0	80
Total	171	151	153	0	52	527
Average	34.2	30.2	30.6	0	10.4	105.7
kg/ha/yr	0.008	0.007	0.007	0	0.002	0.025
Adjusted	0.08	0.07	0.07	0	0.02	0.25

* Indian Permit Record.

Appendix 3. History of the commercial fishery production on Hanson Lake from 1928 to 1989 inclusive (weight in kilograms).

Year	Lake Whitefish	Walleye	Lake Trout	Northern Pike	Other	Total	No. Licenses
1928-29	16057	272	-	-	-	16329	2
1929-30	23315	3	-	-	-	23318	2
1930-32	no fishing	-	-	-	-	0	0
1932-33	7439	635	1089	680	862	10705	1
1933-35	no fishing	-	-	-	-	0	0
1935-36	19287	1126	842	907	318	22480	4
1936-37	8257	817	490	60	229	9853	2
1937-38	4990	-	454	454	272	6170	2
1938-40	no fishing	-	-	-	-	0	0
1940-41	4967	526	2772	340	159	8764	4
1941-43	no fishing	-	-	-	-	0	0
1943-44	14229	1508	150	454	680	17021	8
1944-50	no fishing	-	-	-	-	0	0
1950-51	10112	552	358	450	-	11472	8
1951-52	17296	3003	343	67	-	20709	7
1952-53	18892	2462	390	1785	-	23529	5
1953-55	no fishing	-	-	-	-	0	0
1955-56	7968	889	738	163	-	9758	11
1956-58	no fishing	-	-	-	-	0	0
1958-59	18135	623	607	1183	-	20548	3
1959-60	20978	1029	94	802	-	22903	3
1960-61	19441	636	150	680	-	20907	2
1961-62	17604	235	489	329	-	18657	3
1962-63	7470	228	164	770	-	8632	3
1963-64	1045	67	64	272	-	1448	2
1964-65	12695	649	70	1333	-	14747	2
1965-66	7195	1095	4	1622	734	10650	5
1966-67	9487	3745	35	2792	-	16059	5
1967-68	4918	291	-	215	-	5424	3
1968-69	4016	170	-	222	-	4408	5
1969-70	11459	784	-	421	-	12664	2
1970-71	15507	284	-	481	-	16272	3
1971-72	8724	305	-	1064	-	10093	2
1972-73	1089	32	-	109	-	1230	1
1973-74	no fishing	-	-	-	-	0	0
1974-75	528	634	-	1118	-	2780	7
1975-76	no fishing	-	-	-	-	0	1
1976-77	473	547	-	630	315	1965	3
1977-78	no fishing	-	-	-	-	0	0
1978-79	45	73	-	36	-	154	1
1980-81	59	225	-	33	-	317	1
1981-82	no fishing	-	-	-	0	0	1

Appendix 3. History of the commercial fishery production
on Hanson Lake from 1928 to 1989 inclusive
(weight in kilograms). (continued)

Year	Lake Whitefish	Walleye	Lake Trout	Northern Pike	Other	Total	No. Licenses
1983-84	no fishing					0	0
1984-85	780	390	-	490	-	1660	1
1985-86	117	218	-	245	-	580	2
1986-87	37	232	-	306	-	575	1
1987-88	no fishing					0	0
1988-89	48	80	-	60		188	1
Total	314659	24365	9303	20573	3569	372469	119
% total	84.5	6.5	2.5	5.5	0.9		
Avg kg/ha	75.1	5.8	2.2	4.9	0.8	88.9	
kg/ha/yr	1.5	0.12	0.04	0.09	0.02	1.78	
<u>1970-1989</u>							
Total	27407	3020	0	4572	315	35314	25
% total	77.6	8.5	0	12.9	0.9		
Avg/kg/ha	6.54	0.72	0	1.09	0.08	8.43	
kg/ha/yr	0.59	0.07	0	0.1	0.01	0.77	

Appendix 4. Number of fish caught and spawned during spawn camps on Bad Carrot River between 1975 and 1984.

Year	Males	Females	Mean eggs/female (in ounces)
1984*	3524	530	13.8
1983	5415	1104	12.8
1982	4967	2187	12.2
1981	6080	1825	11.0
1980	7562	1287	9.8
1979	3399	764	14.6
1978	10215	932	15.2
1977	4759	628	12.9
1976	2771	752	15.8
1975	3080	915	10.2
Mean	5177	1090	

*Entire spawning run not caught due to complications of high water levels.